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AGRICULTURAL

EXPERIMENT STATION,

HANOVER, N. H.,

BULLETIN NO. 2.

FEEDING EXPERIMENTS.

JUNE, 1888.

The prime object in planning the feeding experiments recorded in this Bulletin was to determine as far as possible the actual feeding value of the ensilage produced from the different varieties of corn described in Bulletin No. 1, and incidentally to note the cost of a quart of milk or a pound of butter with the various rations used.

The animals experimented on were a mixed herd of young and mature cows in various stages of lactation, from fresh in milk to six months after parturition. Half of the herd had been bought from farmers and were native cows, there were four heifers with their first calves, and the remainder were thoroughbred Shorthorns. Taking all together they were a fair lot of cows, weighing at beginning of experiment an average of 948½ pounds.

The kinds of fodder and grain used were corn fodder or stover, bean vines, mixed hay containing a large proportion of alsike and red clover, millet cut when seed was fully formed, mixed grain consisting of ninety pounds of northern corn ground together with the cob, and twenty-five pounds of oats. gluten meal from the Chicago Glucose Works, buckwheat ground with hulls not separated, and clear corn meal ground from northern corn.

Lack of means and help prevented the analysis of part of the materials used, but the best average results of analyses of other years was taken as a guide to the composition of the rations used. The ensilage was analyzed, giving the following results, as taken from Bulletin No. 1:

	Water.	Dry substance.	Albumenoids.	Nitrogen free extract	Ether extract.	Fibre.	Ash.	Ash contain'd	
								Phosphoric acid.	Potash.
Southern,	75.40	24.90	2.36	14.58	0.58	5.95	1.13	.0269	.0917
Northern Field,	72.40	27.60	2.65	17.17	1.30	4.79	1 69		
Sanford,	77.20	22.80	2.11	13.85	1.08	4.81	.93		
Pride of the North,	70.45	29.55	3.25	16.90	1.59	6.04	.1.77	.0888	.0342
Samples taken:									
Dec. 7, from silo, Sanford,	69.76	30.24	3.09	18.82	1.65	5.32	1.36	.0556	.1171
Dec. 15, " Southern,	78.8	21.2	2.04	10.54	1 37	5.89	1.33	.0484	.1093
1886, Northern Field Corn,	70.55	29.45	2.65	18.84	.90	6.00	1.05		

The northern field corn ensilage was not analyzed after it was put in the silo, but from the analyses of last year I have placed in the table figures that will not vary much from the true analysis.

The cost per ton as harvested was as follows:*

Southern corn,	$2.21,	shrinkage in silo	16.5%
Sanford,	2.48	" "	5.5%
Northern field,	2.40	" "	23.%

The shrinkage of the Northern field corn is excessive, partly due to freezing to side of silo, and partly to a defective bottom of material left over from last year's filling: as nearly as could be estimated these accidental losses would reduce the actual shrinkage to 20%.

The actual cost then per ton as fed out would be as follows: Southern, $2.64; Sanford, $2.62; Northern, $3.00.

The price per ton for grains as figured from the market price of last winter was:

Corn and oats (mixed grain),	$26.00 per ton.
Gluten meal,	26.00 "
Corn and cob meal,	20 00 "
Buckwheat,	20.00 "
Corn fodder and bean vines,	5.00 "
Mixed hay,	8.00 "
Millet,	5.00 "

I have based the price of hay on the market value here in the barn, choice hay selling for $9.00, but this being the first year's crop was of less value on account of the old stubble which it contained. The corn fodder, millet and bean vines I have rated at $5.00, which is slightly more than they would sell for but is very close to their actual feeding value as compared with hay at the above mentioned price. With these figures as a basis we are in position to determine the cost of milk and butter with our own herd and under our own conditions, and also to note how a change of food affects the cost of the product.

The silo was opened in November and the whole herd were accustomed to the ensilage before the experiments were started.

*See method of determining cost, Bulletin No. 1, p. 3-5.

Dec. 6th the herd was put on the following rations per head: Sanford ensilage, 50 lbs.; mixed hay (largely clover), 5 lbs.; bean vines, 5 lbs.; mixed grain, 1¼ lbs.

The ration was the same as had been fed for some time previous, and was continued until the 12th, when the Sanford ensilage was all fed, and the next in order was Southern corn. In each case the corn was cut when the silo was filled.

Dec. 12, the ration was modified by substituting 50 pounds of the Southern in place of the 50 pounds of Sanford ensilage. No other part of the ration was changed, hence any considerable change must be due to a difference in the feeding value of the two kinds of ensilage. After feeding this ration for seven days it was decided to increase the grain ration and accordingly from the 19th to the 26th four pounds of mixed grain was fed to each animal instead of the 1¼ pounds previously fed. From the 26th to January 8th this ration was still further enriched by the addition of two pounds of ground buckwheat, and from Jan. 9–13 the grain ration consisted of two pounds of clear corn and cob (no oats being mixed with these) and three pounds of gluten meal. At this point the Southern ensilage was used up, and the Northern field corn came next. This was put in whole and was full of well matured ears which had kept perfectly and were as bright as when put in.

The milk of ten of the cows was weighed and recorded morning and night as was the total milk for the herd, and in the following table I have arranged the average daily product of each of these ten as well as the total for the herd for periods of seven days, and in the same table is shown the daily ration per cow and its cost as well as the amount of milk required to make a pound of butter, and also the cost of a quart of milk and a pound of butter.

I have given the cost per quart of milk for the best cow and for the poorest; also the average cost for the ten cows whose milk was weighed daily, and the average cost of the total product. It must be remembered that this last is affected by the fact that several or the cows had been long in milk, and consequently the cost per quart was higher than would have been the case with many winter herds, but taken all together the results would represent a very fair yearly average for the entire num-

ber. These results may therefore be taken as representative figures for cows under ordinary conditions.

In the cuts given I have represented the results contained in Table A in such a way that it is possible to see at a glance the leading features of the results therein recorded. A word in explanation of cuts 1 and 2 may be necessary. The first column shows the number of the cow and corresponds with the first column in Table A. The second column shows the scale of pounds and from this it is possible to determine the average daily product of any cow for any period. The figures from one to twenty-one across the top show the periods and correspond with the top line of figures in Table A. The curved lines running across the cut show the average product of milk for each cow and for the whole herd. The dotted lines running parallel to columns one and two represent the periods and are of use in determining how much milk was given at any definite time. For example suppose we wish to know how much milk cow No. 17 gave daily during the 8th period. Follow the curved line marked 17 in first column out to the point where it crosses the dotted line representing Period 8 (this point I have marked a). Now this point is opposite 7.4 in column second, showing that No. 17 during Period 8 averaged 7.4 lbs of milk daily. Any other yield for any period may be determined in the same way. Taken as a whole the curved lines by their upward or downward variation indicate respectively an increase or a decrease of daily milk product. Hence a general upward variation would indicate that for some reason, most probably a change of food, the cows were giving more milk. A gradual downward tendency might indicate a natural shrinkage as time elapsed. But a sudden downward variation would most probably show a less efficient ration. With these points in mind a study of Cut 1 and Table A may show something of value in feeding for milk.

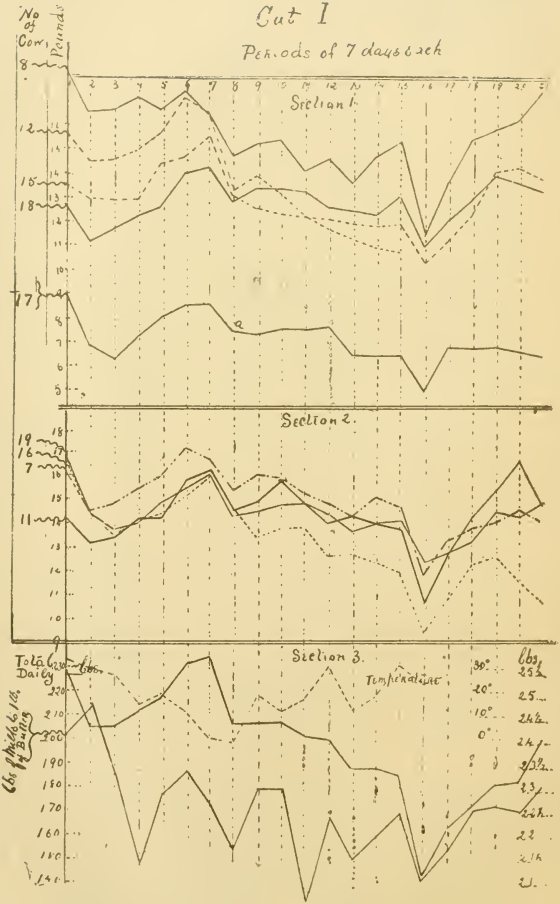
Commencing with the first period there is a substantial and very uniform shrinkage, as shown not only by the individual averages (Cut 1, Sec. 1 and 2) but also by the total yield, Sec. 3. This shrinkage, amounting to from five to twenty per cent, can only be traced to one cause, namely, the substitution of fifty pounds of Southern corn ensilage for fifty pounds of Sanford ensilage. So general and so large a falling off cannot be at-

Period.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
No. of cow.	Dec. 18th, 6–11.	12–18.	19–25.	26 to Jan. 1, 1888.	2–8.	9–13.	14–22.	23–29.	30 to Feb. 5.	6–12.	13–19.	20–26.	27 to March 4.	5–11.	12–18.	19–25.	26 to April 1.	2–8.	9–15.	16–22.	23–29.	30 to May 6.
2	13.75	12.39	12.75	12.64	13.20	14.05	14.31	13.21	13.25	13.10	13.00	12.46	12.25	12.05	12.00	10.5	11.35	12.68	13.1	13.85	14.71	
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22.00	20'68	21'02	21.28	19.21	18.78	19.82	20.00	20.43	21.21	21.07
7	16.21	14.50	14.75	15.36	15.93	17.10	16.61	15 25	15.9	13.80	15.2	14.75	14.2	14.96	14.53	11.7	13.1	13.6	13.9	14.4	13.8	13.6
8	18.37	16.57	16.61	17.18	16.64	17.45	16.39	14.75	15.25	15.39	14.1	14.60	13.6	14.68	15.3	11 4	13.6	15.4	15.8	16.2	17.4	18.8
11	14.12	13.11	13.39	14 14	14.18	15 70	16.17	15.39	14.8	15.60	14.75	14.25	13.46	13.9	14.00	12.2	12.6	13.1	14.3	14.1	14 7	14.4
12	15.75	14.50	14.61	15.07	15.75	17'20	16.50	13.30	13.95	13.20	12.18	11.7	11.3	10.95	10.68	7.2	7.00	6.6	8.2	7.00		
15	13.58	12.89	12.86	12.86	14.43	14.75	15.56	13.10	12.5	12.30	12 2	12.1	11.9	11.8	11.9	10.2	11.2	12.3	14.00	14.2	13.7	
*16	16.58	14.32	13.53	14.14	14.39	15.10	15.97	14.50	13.4	13.80	13.82	12.6	12.7	12.4	12'00	9.43	10.75	12.25	12.6	11.5	10.6	
*17	9.04	6.8	6.32	7.21	8.00	8.55	8.58	7.40	7.32	7.53	7.46	7.6	6.4	6.4	4.9	6.7	6.7	6.8	6.6	6.4		
*18	12.75	11.21	11 71	12.25	12.61	14.05	14.25	12.80	13 4	13.40	13.25	12.6	12.46	12.3	13.00	10.9	12.00	12.9	13.9	13.6	13.2	
*19	16.75	14.36	13.71	14 00	14.82	11.05	15.97	14.32	14.53	14.75	14.82	14 00	14.25	14.00	13.76	10.6	12.6	14.2	15.4	16.6	14.7	
Total milk daily, herd	229.2	204.86	205.57	212.00	217.54	231.45	234.50	206.18	206.53	207.00	201.5	200.00	187.68	189.1	184.32	144.22	163.4	172.00	181.00	182.6	200.7	
Cost of milk, per quart. To produce 1 lb. butter.	Cents 23.7	Cents 27.45	Cents 28.13	Cents 28.35	Cents 30.00	Cents 26.9	Cents 19.7	Cents 23.7	Cents 27.3	Cents 24.1	Cents 22.3	Cents 24.9	Cents 24.8	Cents 25.8	Cents 25.8	Cents 23.4	Cents 27.6	Cents 34.9	Cents 29.4			
Highest.	2.69	3.58	5.09	5.05	4.64	4.02	3.12	3.91	3.95	3.84	3.92	3.80	4.53	4.53	4.53	4.73	4.32	5.7	5.00			
Lowest.	1.32	1.47	1.94	2.13	2.23	1.97	1.61	1.88	1.82	1.83	1.91	1.31	1.40	1.38	1.36	1.20	1.54	1.90	1.72			
Av. for 10 cows.	1.655	1.864	2.473	2.709	2.687	2.365	1.786	2.236	2.15	2.15	2.21	2.28	2.36	2.34	2.34	2.28	2.60	3.18	2.66			
Av. for herd.	2.02	2.27	2.98	3.27	3.25	2.83	2.17	2.58	2.56	2.57	2.64	2.39	2.54	2.53	2.58	2.79	2.90	3.66	3.25			
Average lbs. of milk to 1 lb. butter.	Lbs 25.25	Lbs 25.9	Lbs 24.46	Lbs 22.5	Lbs 24.0	Lbs 24.5	Lbs 23.8	Lbs 22.8	Lbs 24.1	Lbs 24.13	Lbs 21.7	Lbs 23.5	Lbs 22.6	Lbs 23.7	Lbs 23.6	Lbs 22.1	Lbs 22.8	Lbs 23.6	Lbs 23.7	Lbs 23.6	Lbs 24.1	
Daily Ration. Ensil. Sanford.	50																					
Ensil. Southern.		50	50	50	50	50			50	50	50	50	50	50	50							
Ensil. Northern.							50	50	50	50	50	50	50	50	50		50					
Dry fodder. Mixed hay, (largely clover).	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5			
Dry fodder. Herdsgrass hay.																†10.5						
Dry fodder. Corn fodder.					6	6	6	6										8	8			
Dry fodder. Bean vines.	5	5	5	5																		
Dry fodder. Millet.									6	6	6	6	6	6	6	6	6	6	6			
Grain. Mixed grain.	1¼	1¼	4	4	4			2	2	2	2	2	2	2	2	2	2	9½	8			
Grain. Buckwheat.				2	2																	
Grain. Gluten.						3	¾															
Grain. Corn & cob meal.						2	½															
Cost of daily ration per head.	$ 0.11½	$ 0.11⅓	$ 0.15	$ 0.17	$ 0.17⅓	$ 0.16	$ 0.12½	$ 0.13½	$ 0.13½	$ 0.13½	$ 0.13½	$ 0.13½	$ 0.13½	$ 0.13½	$ 0.13½	$ 0.10¾	$ 0.13½	$ 0.17¾	$ 0.16			

*Heifers with first calves.

TABLE A.

†Cows were fed all the hay they would eat and weight noted.


Cut I
Periods of 7 days each
No of Cows
Pounds
Section 1.
Section 2.
Section 3.
Total Daily Yield
Temperature
Lbs

tributed to accidental causes, and as the nature of the food was the same, there being no radical change, one succulent food being exchanged for another equally succulent, it cannot be said that the digestive organs were in any way overtaxed. Neither was the food less palatable for it was perfectly preserved and greedily eaten. There is no escape from the conclusion that the Southern corn ensilage was less valuable in the feeding barn as its analysis shows it to have been in the laboratory. The next step was to increase the grain ration by feeding four pounds of mixed grain instead of 1¼. Looking at our curved lines in Cut 1 from *period two to three* it is found that in four of the individual records a small shrinkage still manifests itself. In five cases there is a small increase in product while the total milk, Sec. 3, remai s almost constant, there being but 7-10 of a pound increase daily on the milk of the entire herd. There is reason for believing that this ration, had it been fed at the commencement of Period 2, would have kept up the flow or at least would have come very near to it, but from the bottom of Table A it is seen that the ration for the third period cost fifteen cents daily for each cow while for Period 1 it cost but 11⅓ cents.

During the *fourth period* a still further addition was made of two pounds of ground buckwheat, increasing the cost of the ration to seventeen cents per head daily. The effect of this was to increase the daily yield of eight of the cows, as shown by the upward direction of the lines in the cut, one, No. 15, remaining stationary, while the total milk increased 3⅓%

Period five was like four, except that six pounds of corn fodder were fed in place of five pounds of bean vines, but as the feeding value of the two is nearly identical this variation was probably without effect. All of the cows, except No. 8, increased in quantity during this period, and by the indication of the lines in the cut it appears that the increase was nearly identical with the previous period.

Period sixth. A radical change was made in the grain fed, gluten meal three pounds and corn and cob meal two pounds being used, the ensilage and dry fodder remaining the same. The result was a decided increase, the total yield coming up to and slightly surpassing the yield at the commencement of the work. This closes the work with Southern ensilage, and gives

us data for determining the relative economy of the Sanford and Southern varieties of corn. The first period is the closing part of nearly a month of almost identical feeding, during which the individual record was kept, but as the complete record of total milk was not made the experiment is considered to have commenced at the date indicated in Table A, and although the figures for the Sanford feeding appear for a short period they are really the last seven of a twenty-one days period, during which time the averages were very close to those given.

TABLE B.

Period (7 days each),	1	2	3	4	5	6
	lbs	lbs	lbs	lbs	lbs	lbs
Milk produced,	1604.4.	1434.	1439.	1484.	1512.8	1620.
Cost of food,	$15.06	$15.06	$19.95	$22.61	$23.00	$21.28
	cts.	cts.	cts.	cts.	cts.	cts.
Cost per qt. of milk,	2.02	2.27	2.98	3.27	3.25	2.83

Table B is intended to show the actual amount of milk produced by the herd for each period, also the value of the food consumed in producing the same and the cost of food per quart of milk.

This table shows that on account of the change from Sanford to Southern ensilage it became necessary to increase the grain ration from 1¼ lbs. of mixed grain, to six pounds of mixed grain and buckwheat before the yield was restored to its former amount, and in so doing the cost of a quart of milk was increased from 2.02 cents to 3¼ cents. Or if we take the cost of the milk required to make a pound of butter it is increased from 23.7 cents to 30 cents, an increase of 26½%.

During the sixth period the grain was changed, reducing the cost of the daily ration 1⅓ cents, but in no way decreasing its efficiency. The result of this change was to produce milk at 2.83 cents per quart, and butter at 26.9 cents, a cost still 13½% above the cost while the Sanford corn ensilage was being fed. These figures show a most decided difference in favor of an ensilage produced from mature corn with a good proportion of ears that were well past the boiling stage, or as is commonly said "past the milk."

The next feeding was with Northern corn ensilage, stored whole. Unfortunately an important step in the investigation

was omitted at this point which prevents a direct comparison of the Southern corn ensilage and the Northern. There should have been two or three periods of feeding and the same grain ration as that used in Period 6. Instead of this the grain ration was reduced to a very small amount, 1¼ lbs of gluten and corn and cob meal. With this reduction the yield fell off in a few cases, but in the majority of the records it increased, reach- a maximum during the seventh period in the total yield. The new ration gave an increase of 13%. reducing the cost of a quart of milk from 2.83 cents to 2.17 cents, thus nearly reaching the level of the first period.

Period eighth shows a marked falling off in yield of milk in all cases. The total for herd falls off 12%, the total for the ten cows whose individual record was kept drops 11%. The only change of food in this period was the substitution of two pounds mixed corn and oats in place of the gluten and corn mixture of Period 7, but as only 1¼ pounds of the latter had been fed the two pounds would be fully equivalent, hence we must look for some other cause for this sudden decrease. In Cut 1, Sec. 3, I have plotted a curve representing the average temperature for each period. This curve is made up from Table C.

TABLE C.

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Av. temp. in degrees,	35	30	27	15	19	11½	0	−1	18½	12	17	31	12	18½	31½	24	28

These are out door and not stable temperatures.

It was noticed that the temperature was not sufficiently variable to make any appreciable difference in-doors during the first six periods, but during the 7th period there were two days of very cold weather followed by a few days of warm weather. These two days brought down the average temperature but did not affect the milk flow as the stable temperature was not greatly reduced, but in the eighth, a severe period of windy days, unusually low temperature, made the stables very cold. This condition of affairs undoubtedly caused the falling off in product, and therefore the food cannot be charged with being of less nutritive value. During Periods 9 and 10 there was an increase of milk, but only slight. From 10 to 15 there is a comparatively uniform falling off amounting to 2% per period.

The result of this was to slightly but constantly increase the cost per quart of milk.

Period 16 marks a radical change of food and a sudden falling off of milk flow, amounting to nearly 22%. The food for this period was early cut herdsgrass hay, clover mixture, and the same grain mixture as previously fed. So radical a change from succulent food to dry fodder might naturally be expected to cause a shrinkage out of proportion to the actual fall of feeding value of fodder, but it will be noticed that although the cows were fed all they would eat yet there was but 10½ pounds eaten daily, which, at the prices adopted for estimating values makes the cheapest daily ration fed so far as actual cost is concerned. The shrinkage was so great that financial considerations induced us to change the ration at the end of a single period back to the former ensilage ration, and by so doing the yield was brought back by half the amount of the previous shrinkage.

At this point the ensilage gave out and in its place a ration containing cured corn fodder was substituted, also a large addition was made to the grain portion of the food. A substantial increase of milk was the result.

TABLE D.

LIVE WEIGHT OF TEN COWS FOR TWENTY-ONE PERIODS.

Period,	1	2	3	4	5	6	7	8	9	10	11
Weight,	9049	9119	9083	9003	9145	9157	9127	9006	9101	9097	9221
Period,	12	13	14	15	16	17	18	19	20		
Weight,	9107	9154	9069	9119	8905	9280	9358	9254	9399		

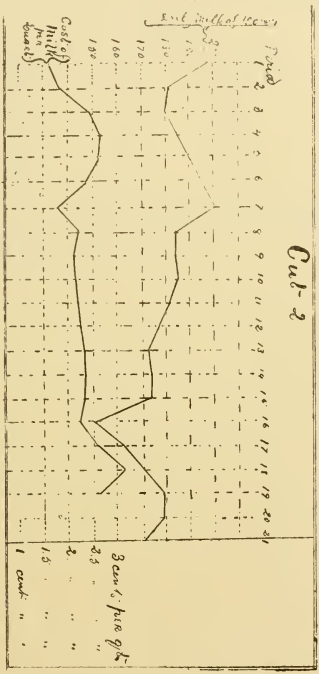
This shows a moderate increase in live weight throughout, though in Period 8 the effect of the cold weather is indicated by a shrinkage.

Cut 2 shows by a curved line the daily yield per period of the ten cows whose individual record was kept, and also by another curve, the price per quart of milk. This last is important, showing as it does the financial side of the whole work.

COST OF PRODUCING MILK.

Commencing at Period one we find the cost to be 1.65 cents per quart. Changing onto Southern ensilage increases this to 1.86 cents, and in our efforts to restore the loss of yield

by feeding more meal we made milk at a cost of 2.47, 2.70, 2.68 and 2.36 cents. The upward tendency of the curves in periods



2–5 show increased cost. Period 6 shows that a substitution of gluten meal instead of the grain previously fed had the effect of materially reducing the cost. Period 7 marks a low cost and a high yield. With the loss of yield in Period 8 we note an increased cost, and then follows several periods of dimishing yield and slowly increasing cost. Period 16 shows an unusual circumstance; the sudden falling off of milk would under most circumstances be attended by an increased cost per quart, but in this case both quantity and cost go down at the

same time. This is followed by a sharp increase both in quantity and cost.

Taking all the results as they stand our ten cows produce milk at the following average prices:

TABLE E.

Food.	Whole Herd. cts. per qt.	Ten Cows. cts. per qt.	*Best Cow. cts. per qt.	Poorest Cow. cts. per qt.
Sanford,	2.02	1.65	1.32	2.69
Southern Corn,	2.92	2.44	1.95	4.49
Northern Corn,	2.54	2.24	1.66	4.04
Hay,	2.79	2.28	1.20	4.73
Corn Fodder,	3.45	2.92	1.81	5.35

*After the 13th period a new cow, No. 4, came in and this reduced the individual cost of milk produced for "best cow."

G. H. WHITCHER,

Director.

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